

1. A heat-shrinkable food packaging film having an interior surface and an exterior surface, the film comprising:

- (a) a food contact layer comprising a myoglobin blooming agent, and
- (b) an oxygen barrier layer;

wherein the film has a free shrink value at 90 °C. or less of at least 10% in at least one direction.

2. A film, as defined in claim 1, wherein the film has a total free shrink value at 90°C or less of at least 60%.

3. A film, as defined in claim 1, wherein the oxygen barrier layer comprises PVDC, EVOH, polyamide, nanocomposite, PET, or a combination thereof.

4. A film, as defined in claim 1, wherein the film has an oxygen transmission rate of less than  $310 \text{ cm}^3/\text{m}^2/24 \text{ hours}$  measured at 0% relative humidity and 23 °C.

5. A film, as defined in claim 1, wherein the film has an oxygen transmission rate of less than about  $75 \text{ cm}^3/\text{m}^2/24 \text{ hours}$  measured at 0% relative humidity and 23 °C.

6. A film, as defined in claim 1, wherein the film has an oxygen transmission rate of less than  $20.0 \text{ cm}^3/\text{m}^2/24 \text{ hours}$  measured at 0% relative humidity and 23 °C.

7. A film, as defined in claim 1, wherein the film further comprises an exterior surface layer (c), and wherein the oxygen barrier layer (b) is positioned between layer (a) and layer (c).

8. A film, as defined in claim 7, wherein the film is at least five polymeric layers and has a first tie layer (d) positioned between the food contact layer (a) and oxygen barrier layer (b) and a second tie layer (e) positioned between the oxygen barrier layer (b) and the exterior surface layer (c).

9. A film, as defined in claim 7, wherein the exterior surface layer (c) comprises a homopolymer or a copolymer of nylon, polyethylene terephthalate, polyolefin, or blends thereof.

10. A film, as defined in claim 1, wherein the food contact layer (a) comprises a homopolymer or a copolymer of a polyolefin or blends thereof.

11. A film, as defined in claim 7, wherein at least one layer of the film is crosslinked.

12. A film, as defined in claim 7, wherein at least one layer of the film is irradiatively crosslinked.

13. A film, as defined in claim 1, further comprising at least one additional layer of a polyamide, a polyester, a polyethylene, a polypropylene, a polybutylene, a polystyrene, a polyurethane, a polyacrylamide, an anhydride-modified polymer, an acrylate-modified polymer, or copolymers or blends thereof.

14. A film, as defined in claim 1, wherein the myoglobin blooming agent is selected from the group consisting of: Fremy's salt, nitrate salts having the formula  $(MNO_3)$  and inorganic nitrites  $(MNO_2)$ , where the counter ion  $(M^+)$  is selected from the group consisting of: alkali metals, alkaline earth metals, transition metals, protonated primary, secondary or tertiary amines, quaternary amines, and ammonium.

15. A film, as defined in claim 1, wherein the myoglobin blooming agent containing layer further comprises at least one of an antioxidant, a slip agent, an

antiblock agent, a colorant, a flavorant, an odorant, an organoleptic agent, a coefficient of friction modifying agent, a lubricant, a surfactant, an encapsulating agent, an oxygen scavenger, a pH modifying agent, a film forming agent, an emulsifier, a polyphosphate, a humectant, a drying agent, an antimicrobial agent, a chelating agent, a binder, a starch, a polysaccharide or a combination thereof.

16. A film, as defined in claim 1, wherein the food contact layer comprises between about 0.10 weight % and about 5.0 weight % of the myoglobin blooming agent.

17. A film, as defined in claim 1, wherein the food contact layer comprises at least about 0.10 weight % and less than 2.0 weight % of the myoglobin blooming agent.

18. A film, as defined in claim 1, wherein the food contact layer has on its food contact surface of from 0.01 to 10  $\mu\text{mole}/\text{inch}^2$  of the myoglobin blooming agent.

19. A film, as defined in claim 1, wherein the food contact layer has on its food contact surface of from 0.01 to 2  $\mu\text{mole}/\text{inch}^2$  of the myoglobin blooming agent.

20. A film, as defined in claim 1, wherein the food contact layer has at least 0.1  $\text{mg}/\text{inch}^2$  of the myoglobin blooming agent.

21. A film, as defined in claim 1, wherein the food contact layer has an its food contact surface less than 0.25  $\text{mg}/\text{inch}^2$  of the myoglobin blooming agent.

22. A film, as defined in claim 1, wherein the food contact layer comprises a heat sealable polymer.

23. A film, as defined in claim 1, wherein the food contact layer comprises a heat sealable polymer selected from the group of polyolefin,

polyethylene, VLDPE, LLDPE, LDPE, HDPE, ethylene alpha – olefin copolymers, polypropylene, polybutylene, and ionomer.

24. A film, as defined in claim 1, wherein at least 10% of the surface area of the film is transparent.

25. A film, as defined in claim 1, wherein the film has a gloss value of at least 70 at 45°.

26. A food package comprising:

a myoglobin-containing food product having a water content of at least 5 wt. %; and

a container comprising a heat shrinkable, oxygen barrier film having a food contact layer comprising a nitrogen or sulfur containing myoglobin blooming agent;

wherein the container encloses the food product in a reduced oxygen environment and at least a portion of the film food contact surface is in contact with at least a portion of a surface of the myoglobin-containing food product.

27. A food package, as defined in claim 26, wherein the myoglobin blooming agent is selected from the group consisting of: Fremy's salt, nitrate salts having the formula  $(MNO_3)$  and nitrite salts  $(MNO_2)$ , where M is a counter-ion  $(M^+)$  selected from the group consisting of: alkali metals, alkaline earth metals, transition metals, protonated primary, secondary, tertiary amines, quaternary amines, and ammonium.

28. The food package of claim 26, wherein the food product is maintained in a vacuum.

29. A food package, as defined in claim 26, wherein at least a portion of the film food contact layer is transparent and in contact with the food product.

30. A food package, as defined in claim 29, wherein the container further comprises a tray.

31. A food package, as defined in claim 30, wherein at least a portion of the food product is maintained in contact with a modified atmosphere having an elevated level of carbon monoxide, nitrogen, an oxide of nitrogen, oxygen, or mixtures thereof.

32. A food package, as defined in claim 26, wherein the myoglobin blooming agent is nongaseous.

33. A food package, as defined in claim 26, wherein the food product comprises between about 0.1 and 25 mg/g myoglobin.

34. A food package, as defined in claim 26, wherein the food product comprises between about 3 and 20 mg/g myoglobin.

35. A food package, as defined in claim 26, wherein the food product comprises between about 1 and 5 mg/g myoglobin.

36. A food package, as defined in claim 26, wherein the food product comprises less than 1 mg/g myoglobin.

37. A food package, as defined in claim 26, wherein the food product comprises at least 1 mg/g myoglobin.

38. A food package, as defined in claim 26, wherein the food product is selected from the group consisting of: beef, veal, pork, mutton, lamb, poultry, chicken, turkey, duck, goose, game, fish, and seafood.

39. A food package, as defined in claim 26, wherein the food product is primal, subprimal, retail cut, comminuted, ground, or a combination thereof.

40. A food package, as defined in claim 26, wherein the food product is fresh, frozen, hard chilled, or thawed.

41. A food package, as defined in claim 26, wherein the film has an oxygen transmission rate of less than about  $310 \text{ cm}^3/\text{m}^2/24 \text{ hours}$  measured at 0% relative humidity and 23 °C.

42. A food package, as defined in claim 26, wherein the film has an oxygen transmission rate of less than about  $20 \text{ cm}^3/\text{m}^2/24 \text{ hours}$  measured at 0% relative humidity and 23 °C.

43. A food package, as defined in claim 26, wherein the package comprises a pouch, bag, casing, overwrapped tray or form shrink package.

44. A food package, as defined in claim 26, wherein the package is hermetically sealed.

45. A food package, as defined in claim 26, wherein the food contact layer has a uniform distribution of myoglobin blooming agent on its surface.

46. A food package, as defined in claim 26, wherein the food contact layer comprises between about 0.1 weight % and about 5.0 weight % of a myoglobin blooming agent incorporated therein.

47. A food package, as defined in claim 26, wherein the food contact layer comprises at least about 0.1 weight % of a myoglobin blooming agent incorporated therein.

48. A food package, as defined in claim 26, wherein the food contact layer comprises less than 2.0 weight % of a myoglobin blooming agent incorporated therein.

49. A food package, as defined in claim 26, wherein the food contact layer comprises between about 0.75 weight % and about 1.75 weight % of the myoglobin blooming agent.

50. A food package, as defined in claim 26, wherein the myoglobin blooming agent is present in an amount sufficient to cause the myoglobin containing food product when hermetically sealed in a vacuum to have a colored food surface which at least 10 days after packaging is a visible red hue.

51. A food package, as defined in claim 26, wherein the myoglobin containing food product has a water content of at least 40 wt.%.

52. A food package, as defined in claim 26, wherein the myoglobin containing food product has a water content of at least 60 wt.%.

53. A food package, as defined in claim 26, wherein the myoglobin containing food product has a sodium chloride content of less than 2.0 wt.%.

54. A food package, as defined in claim 26, wherein the myoglobin containing food product has a sodium chloride content of 1.0 wt.% or less.

55. A food package, as defined in claim 26, wherein the myoglobin containing food product has a combined nitrite and nitrate content of less than 0.012 wt.%.

56. A food package, as defined in claim 26, wherein the myoglobin containing food product has a combined nitrite and nitrate content of less than 0.005 wt.%.

57. A food package comprising:

a myoglobin-containing food product having a water content of at least 5 wt. %; and

a container comprising a heat shrinkable, oxygen barrier thermoplastic film having a polymeric food contact layer and a tray;

wherein the container encloses the food product in a reduced oxygen environment; and the food product is maintained in a modified atmosphere comprising a nitrogen or sulfur containing gaseous myoglobin blooming agent, or mixtures thereof.

58. A method of packaging a myoglobin-containing food product comprising the steps of:

providing a food product comprising myoglobin having at least 5 wt. % water;

providing a heat shrinkable packaging film having an oxygen transmission rate of less than about  $310 \text{ cm}^3/\text{m}^2/24 \text{ hours}$  measured at 0% relative humidity and 23 °C and having a total free shrink of at least 10% at 90° C;

contacting the food product with a food contact surface of the packaging film wherein between about  $0.001 \text{ mg/in}^2$  and about  $0.500 \text{ mg/in}^2$  of a myoglobin blooming agent is present at the food contact surface; and

hermetically sealing the food product within the film in a packaging environment having a reduced gaseous oxygen partial pressure; and

causing the film to shrink.

59. A method, as defined in claim 58, wherein the food product is packed less than 20 days post-mortem.



60. A method, as defined in claim 58, wherein the food product is packed less than 12 days post-mortem.

61. A method, as defined in claim 58, wherein the food product is packed less than 24 hours post-mortem.

62. A method, as defined in claim 58, wherein the food product is selected from the group consisting of: beef, veal, pork, mutton, lamb, poultry, chicken, turkey, duck, goose, game, fish, and seafood.

63. A method, as defined in claim 58, wherein the heat-shrinkable film has a total free shrink measured at 90 °C. of at least about 40%.

64. A method, as defined in claim 58, wherein the food product comprises at least about 0.1 mg/g of myoglobin.

65. A method, as defined in claim 58, wherein the food product comprises at least 1 mg/g of myoglobin.

66. A method, as defined in claim 58, wherein the food product comprises at least 3 mg/g of myoglobin.

67. A method, as defined in claim 58, wherein the food product comprises less than 1.0 wt. % sodium chloride.

68. A method, as defined in claim 58, wherein the food product has a combined nitrite and nitrate content of less than 0.005 wt. %.

69. A method, as defined in claim 58, wherein the food product comprises at least 40 wt. % water.

70. A method of manufacturing a vacuum package of fresh meat comprising:

a) supplying a container comprising a heat shrinkable film having a layer comprising a myoglobin blooming agent and wherein the film is substantially impermeable to oxygen;

b) placing a retail cut of fresh meat within the container;

c) removing the atmosphere within the container;

d) causing transparent portion of the film to make direct contact with at least a portion of the meat surface;

e) hermetically sealing the container to enclose the fresh meat and prevent contact of oxygen from outside the container therewith;

f) shrinking the film to provide a compact package having a sufficiently reduced internal oxygen level to promote a meat surface favoring deoxymyoglobin or metmyoglobin and the corresponding purple and brown colorations associated therewith over formation of oxymyoglobin; and

g) storing the package under refrigeration conditions for a sufficient time to permit the reducing activity of the enclosed meat to favor nitroxymyoglobin formation on the meat surface to an extent whereby a corresponding red color associated therewith is formed to produce a visibly red meat surface.

71. A method, as defined in claim 70, wherein the film has an oxygen transmission rate of less than about  $310 \text{ cm}^3/\text{m}^2/24 \text{ hours}$  measured at 0% relative humidity and 23 °C.

72. A method, as defined in claim 70, wherein the myoglobin blooming agent is selected from the group consisting of: Fremy's salt, nitrate salts having the formula  $(\text{MNO}_3)$  and nitrite salts  $(\text{MNO}_2)$ , where M is a counter-ion ( $\text{M}^+$ )

selected from the group consisting of: alkali metals, alkaline earth metals, transition metals, protonated primary, secondary, tertiary amines, quaternary amines, and ammonium.

73. A method, as defined in claim 70, wherein the food contact layer comprises a heat sealable polymer selected from the group of polyolefin, polyethylene, VLDPE, LLDPE, LDPE, HDPE, ethylene alpha – olefin copolymers, polypropylene, polybutylene, and ionomer.

74. A method, as defined in claim 70, wherein the myoglobin blooming agent containing layer further comprises at least one of an antioxidant, a slip agent, an antiblock agent, a colorant, a flavorant, an odorant, an organoleptic agent, a coefficient of friction modifying agent, a lubricant, a surfactant, an encapsulating agent, an oxygen scavenger, a pH modifying agent, a film forming agent, an emulsifier, a polyphosphate, a humectant, a drying agent, an antimicrobial agent, a chelating agent, a binder, a starch, a polysaccharide or a combination thereof.

75. A method, as defined in claim 70, wherein the fresh meat is selected from the group consisting of: beef, veal, pork, mutton, lamb, poultry, chicken, turkey, duck, goose, game, fish, and seafood.